Internet Exchange – a solution towards cost effective and quality Internet access

Rishi Chawla
LLB, MBA, CCNA, BBA
Country Co-ordinator GIPI India
rishi@gipi.org.in
URL www.gipi.org.in

ABSTRACT

To speed up the spread of the Internet in India, the cost of Internet connectivity and bandwidth must be reduced and the quality of service improved. One of the most effective mechanisms to accomplish both cost and quality benefits is the Internet Exchange Point (IXP). An IXP interconnects Internet service providers (ISPs) in a region or country, allowing them to exchange domestic Internet traffic locally without having to send those messages across multiple international hops to reach their destination. For instance in the absence of an IXP in India the Internet traffic originating from one ISP with a destination of another ISP being just miles away has to make a round-the-world trip, thus consuming international bandwidth which if saved would result in savings of foreign exchange to the country (and also give quality Internet access to the Users) This paper introduces the concept of Internet Exchange and gives out some of the reasons for the need of Internet Exchange in India. It also briefly discusses the Infrastructure required for an IXP as also its Organisation and Management. India today has an Internet subscriber base of just 3.3Million as against the target of 230 Million for the year 2007, and it can be achieved only if the cost of Internet access is brought down and quality improved. IXP is one of the solutions towards achieving this target.

Key Words:
Internet Exchange Definition & Requirement, Benefits, Cost Effective & Better quality Internet Access, Savings in Foreign Exchange, Infrastructure required, services provided

1. INTRODUCTION

To speed the spread of the Internet in India, the cost of Internet connectivity and bandwidth must be reduced and the quality of service improved. One of the most effective mechanisms to accomplish both cost and service gains is the Internet Exchange Point (IXP). An IXP interconnects Internet service providers (ISPs) in a region or country, allowing them to exchange domestic Internet traffic locally without having to send those messages across multiple international hops to reach their destination.

2. Definition of Internet Exchange Point (IXP)

IXP is a layer 2 physical network facility operated by a single entity with the purpose to facilitate the exchange of Internet traffic between three or more Internet Service Providers (ISPs). It is a place for ISPs to interconnect and Exchange IP traffic with each other at a national or international level. In order to provide access to the 'global Internet', an Internet Service Provider (ISP) must, of

course, have connectivity to the global Internet itself and this connection is totally independent of the connection made with the Exchange.

3. Need for IXP in India

IXPs are among the most critical elements in the infrastructure of the Internet. The Internet is a network of interconnected networks; IXPs are the points at which multiple networks interconnect. Without IXPs, there would be no Internet, as we have come to know it. In more concrete terms, IXP in India would result in the following advantages for member ISPs, their customers and the Indian economy at large:

3.1 Lower costs and savings in foreign exchange

ISPs generally buy Internet access (often called 'upstream transit') from one or more of the Tier 1 ISPs. Due to the size of these Tier 1 networks, and their comprehensive interconnection with other networks, they can send and deliver Internet traffic to any network connected to the Internet; i.e. they have connectivity to the global Internet. It is this global connectivity that other ISPs buy (these ISPs are usually referred to as 'Tier 2' ISPs), and in turn sell access to the global Internet to their customers.

Now, consider the situation where there is traffic destined to travel between a customer of one Tier 2 ISP to a customer of another Tier 2 ISP and both the customers are located within India. Both ISPs have to pay their upstream transit providers to deliver and receive this traffic. This is still the case even where both ISPs use the same upstream provider. Consequently, even for Intra-India Traffic, a lot of International Bandwidth is used, which can be avoided, if an Internet Exchange is deployed in India. As a direct relation it will also help reduce outflow of foreign exchange as payment to International Carriers for use of their bandwidth.

3.2 Improved quality of service

In the absence of IXP in India even domestic traffic must be exchanged internationally, entailing at least two satellite hops causing significant latency (delay) in the network. (Even where hard fiber connection is available, the length of transatlantic cables introduces needless latency in the connection.) This significant network latency translates into extremely slow connections for users, putting a tremendous range of Internet services out of practical reach. Local Internet enterprises find themselves at an inherent disadvantage if they attempt to serve international customers.

For instance when a trace route was done on a connection (with Star Broadband) in Malviya Nagar, South Delhi, to another connection (with Hathaway) Green Park, South Delhi (about 5km away), it was found that the route went: Malviya

Nagar (Delhi), Chanakya Puri (Delhi)-Singapore -New York-Germany-Netherlands -UK-Bombay (India)-Green Park (Delhi).
That is a round–the – world - trip to another nearby location.

An IXP slashes network latency by eliminating the need for any satellite hops in the routing of domestic-bound traffic. The result is that more customers use domestic Internet services, increasing local demand for bandwidth and prompting a cycle in which ever more bandwidth is dedicated to local interconnection. Since domestic bandwidth is always cheaper than international bandwidth, the business cases for domestic Internet enterprises improve dramatically – not just for ISPs, but for online banking, e-commerce sites, online government, enterprise VPNs, content hosting, web services, etc.

Regardless of the medium, then, a closer connection will be cheaper, faster, and more efficient. Put another way, the localization of packet traffic – keeping the physical path traversed by packets as short as possible – produces measurable improvements in service cost, performance, and efficiency.

3.3 Increase in Internet Penetration

The resulting lower costs, improved quality of service, faster access due to the IXP will help in increasing the Internet penetration in India and thus achieve the planned projections of 230 Million Internet users by the end of the year 2007

3.4 Provide basic infrastructure for ".in" , "digital signature" and other government initiatives

India Internet Exchange Point can be the central facility to promote initiatives such as ".in", "digital signature verification" and others by deploying suitable applications/servers to allow equal access by all member ISPs.

An equal access will ensure the benefit can be availed by business across the country, simultaneously, and without any limitations.

4. Infrastructure

4.1 Architecture

Majority of the IXPs have adopted a layer 2 switched Ethernet architecture. There are examples of other architectures such as ATM and FDDI, however, these are not common. ATM is often not favoured by ISPs since it is a technology that is significantly different to that with which they are experienced, and requires skills to manage that are not always available to them. FDDI does not have these particular issues. It can interconnected with Ethernet based networks, but the speed limitation of 100Mbps, the limited support for FDDI on current layer 2 switch equipment and the probable lack of any further development suggests

that it would not be an appropriate technology for a new IXPs to adopt for its core infrastructure.

One decision will be whether to have single or multiple switch equipment. Financial constraints may mean that the IXP can only afford a single switch, and indeed many successful IXPs have started this way. This may be the only solution initially available to the IXP, however, some observations with regard to the use of multiple switches are discussed here to provide some assistance in planning for the future growth of an IXP, even where the IXP has had to be established with modest resources.

The major benefit of building a multiple switch IXP is redundancy. This may be purely physical redundancy by using more than one switch from a single vendor, or physical and 'genetic' redundancy by using switches from two or more vendors. Single vendor redundancy can help to ensure the operation of the IXP in the case of a hardware failure but not certain software (or firmware) failures that may be common to all devices from that vendor. Multiple vendor redundancy can potentially help in both failure modes; it is unlikely that a software bug causing the failure of one vendor's equipment will also affect another vendors' equipment. Against this some other factors should be considered; equipment from a single vendor may provide better economies of scale in purchasing, spares holding, maintenance and management than that of two or more vendors; also interoperability issues are more likely with equipment from multiple vendors.

Multiple switch IXPs can offer better continuity of service than a single switch IXP. IXPs with multiple switches often offer, allow, or require members/customers to have two or more connections to two or more physically separate switches. In this situation, should one switch fail the connected member/customer network has an alternative route to the IXP. Continuity of service can also be provided during routine maintenance or upgrade of any one switch device. This, does however, result in increased hardware costs, greater management overhead, and more cost for members/customers, who will require a second router interface and more cabling from their infrastructure to the IXP.

The phenomenal, and sometimes unexpected, growth that many IXPs have experienced would suggest that scaleability is a very important factor. Fortunately, modular 'chassis and blade' switch equipment is available. By purchasing switch chassis and adding interface blades when required an IXP can allow for a reasonable amount of growth and expansion whilst limiting the initial investment. A facet of switch equipment that has changed since the inception of the older IXPs is the availability of higher speed ('fast', 100Mbps and 'GigE', 1Gbps) interfaces. Most; if not all, equipment is currently capable of 100Mbps, and this is often the basic interface standard, however these interfaces can usually also support 10Mbps. Much current equipment is GigE capable, but to

support this speed extra optical interface hardware and other options are usually required. The cost of these are often be high in comparison with the switches and standard interfaces themselves, but the modular design of switches allow an IXP to start with, say, one or two 10/100Mbps blades and add GigE blades to the same chassis when traffic levels demand higher speed interfaces.

In conclusion, the critical nature of the switch infrastructure means that it is advisable for the IXP to invest in the best and most expandable equipment that its financial circumstances allow. Some factors to consider are: modularity/upgradeability, power supply redundancy, management processor redundancy, software update mechanisms, stability of software, interoperability and out-of-band access.

'Collector' router.
To assist the IXP and members in troubleshooting, some IXPs provide a router with which all members peer and announce their routes. The router listens to, or 'collects' these announcements, but does not announce any routes itself, hence some IXPs use the term 'collector' router for this equipment. IXP staff and member ISPs have user accounts on this router, enabling them to have a central 'view' of the IXP, independent of the 'view' through their own connection.

'Transit' router.
Where an IXP has server equipment hosting, for example, their web site and email, and possibly some staff requiring Internet access, a router with full Internet connectivity is obviously required. (With care in configuration, this function can be combined with that of a 'collector' router.)

Address space
Whilst IP address space is not physical equipment, it is worthy of some comment. It is quite possible to operate the IXP using a block of addresses from a member ISP, or even a third party, but for orderly management and administration of the IXP it is preferable for it to have its own address allocation.

4.2 Housing of the IXP

The environment in which an IXP is housed is very important. Some existing IXPs were established in commercial co-location facilities, either in their own dedicated racks or rooms, (e.g. LINX at Telehouse in London) or in rack space belonging to a member ISP. The latter is a low cost and pragmatic solution, but should only be seen as a short-term solution. Expansion of the IXP, access issues and other potential limitations would suggest an IXP have its own dedicated racks as soon as possible.

A number of existing IXPs, particularly those started by institutions, were initially housed by the institution itself, (e.g. VIX, at the University of Vienna), but have more recently expanded to commercial co-location facilities (usually in

addition to the original sites). Whilst IXPs housed by institutions can benefit from low housing costs, and the housing can be perfectly adequate in the short to medium term, a successful IXP is likely to outgrow the space available. Also, access by member ISPs who may have equipment at the IXP may be limited, as may be access by telcos to provide communications circuits.

Whatever the type and location of housing available to a new IXP, the following facilities need to be considered.

Space
Initially, the amount of rack space required needs to be determined. A major factor is whether the IXP will allow members to co-locate router equipment at the IXP. Where an IXP is located in a commercial co-location facility, members may take (or already have) their own rack space in the facility, and can connect a router in their own rack space to the IXP switch infrastructure with an in-building (or on-campus) LAN connection.

Security
IXPs often become critical to their members' businesses, so it is important that the site of the IXP is as secure as possible. The housing space must be equipped with sophisticated security systems, some elements to consider when looking for space are: 24x7 security manning, CCTV coverage (inside and out), and multiple level access control (site, building, room, rack/cage).

Environmental control
The space should be adequately cooled, with high quality air conditioning. Additionally, robust fire detection and suppression systems should be in place.

Power
Much modern switching and routing equipment has the capability of redundant Power Supply Units. To take advantage of this feature there should be provision of at least two power supplies. There should also be on site generators, with battery back-up/switch over to protect against total supply failure. The IXP may also wish to consider having it's own non-interuptable power supply.

Cabling
Given that a large IXP is likely to have 100+ members, many with 2 or more connections to the IXP, consideration should be given to the amount of space available for cabling.

5. Services

Internet Exchange has the option of offering a wide variety of services ranging from basic connectivity to advanced statistical analysis variants. Following is a list of offerings:

Basics :

Peering services to the IXP
Contractual Maintenance of connections
Web Based Information
Publish information about members
Offer link to ISP from IXP web site
Route Server Services
Specifically for ISP-C members

Advanced :

NTP Servers – provide clock information to ISPs for synchronisation with other carriers
Can Connect Secondary TLD DNS Server for India's TLD directory to speed up access
Host ".in" services and similar applications
ISPs can pool WWW Proxy/Cache resources via the IXP hosted Proxy/cache server
Host Multicast Server to help peer "multicast" based traffic among member ISPs
Content Co-location
Registering Route Policy Registry of ISPs
Inter Exchange Services within India and also International IXPs
Provide Statistical Analysis of traffic flowing through peering points

6. Organisation and Management

By function, an Internet Exchange is a non-profit, neutral and independent association, meaning that it has no bias as to who connects (provided they meet the membership criteria) and it's operational decisions are not directly influenced by any financial gains.

Globally Most IXPs grew from non-commercial ventures, such as research organisations (e.g. CIXP, which developed at CERN), academic institutions (e.g. VIX, which was started at the University of Vienna), or collaboration between ISPs (e.g. LINX, which was formed by 4 commercial ISPs and the UK academic network).

Whether commercial or not, virtually all IXPs are owned and managed neutrally with respect to carriers, ISPs and co-location providers. These three types of organisations can all have commercial relationships with the IXP, or with the IXP customers, and therefore if the ownership of the IXP is in their hands potential conflicts of interest may arise. An example that is often quoted is a group of IXPs in the US, which are owned and run by a carrier. The only circuits that may be used to gain access to the IXPs must be purchased from that carrier, thus producing a monopoly situation. This is particularly annoying to other carriers

that have ISP companies, and wish to join the IXPs - they are effectively forced to give business and revenue to a competitor. Many ISPs have expressed strong feelings about the importance of neutrality of IXPs, and most of the larger European IXPs have said that their success has been partly as a result of their neutrality.

7. Market Analysis

7.1 Growing Intra-India Internet Traffic

India is witnessing a major growth in the use of Internet and there is an expectation of further exponential growth over the next 3-5 years. The current Internet subscriber base in India is 3.3 Million and the user base is 16.5 Million. The planned projection is 230 Million by the end of the year 2007.There are around 450 ISPs who have been issued licenses to offer Internet services, out of which over 150 are already operational. With increasing use of Internet this number and the intra-India Internet traffic will grow. It would not be cost effective, scaleable or manageable to interconnect with all of them individually. To peer with each other a common peering point will be required. Internet Exchange Point (IXP) provides a solution to this. An IXP is a single physical network infrastructure, (often an Ethernet local area network) to which many ISPs can connect. Any ISP that is connected to the IXP can Exchange traffic with any of the other ISPs connected to the IXP, using a single physical connection to the IXP, thus overcoming the scaleability problem of individual interconnections. Also, by enabling traffic to take a more direct route between many ISP networks, an IXP can improve the efficiency of the Internet, resulting in a better service for the end user and a lower access cost.

7.2 IXP – missing link in Internet Infrastructure of India

IXP is a missing link in the Internet Infrastructure in India and ISPAI proposes to complete this link by setting up the Internet Exchange of India. Most of the developed countries have IXPs in place, from a long time and the developing countries are catching fast by deploying IXPs to save precious foreign exchange. There are IXPs even in countries which are much smaller in size than India and where the number of ISPs are far too less than India, like Kenya, Mozambique, Indonesia, Pakistan, Mongolia etc. It is high time India also has an IXP in place to reap the benefits illustrated at various places in this report

7.3 IXP will attract Content hosting in India

Currently most of the content targeted to Indian users is hosted abroad, mostly in the US, leading to significant outflow of foreign exchange. A better Internet Infrastructure will attract this content to be hosted in India and will encourage the Indian companies to host content on Indian servers and thus also encourage ".in" domains. Even foreign companies who are targeting their content to Indian

audience will be tempted to host their content in India, this will not only save Foreign exchange but will help in earning more foreign exchange.

8. Internet Exchanges in Asia

Following is a list of some of the Internet Exchanges located in Asia. Note the recent IX to start operations is that of Nepal

China - HongKong Internet eXchange (HKIX)	http://www.hkix.net/
Indonesia - The Indonesia Internet eXchange (iIX)	http://www.iix.net/
Japan - The Japanese Internet eXchange (JPIX)	http://www.jpix.co.jp/
Malaysia - Kuala Lumpar Internet eXchange (KLIX)	http://www.klix.net/
Nepal – (NPIX)	http://www.npix.net.np
Pakistan - Pakistan National Access Point (PNAP)	http://www.nap.com.pk/
Philippines - Philippines Internet eXchange (PHIX)	http://www.phix.net.ph/
Saudi Arabia - Internet Services Unit (KACST-ISU)	http://www.isu.net.sa/
Singapore - SingTel IX	http://www.stix.net/
South Korea - The Korean Internet eXchange (KINX)	http://www.kinx.net/
Taiwan - Taiwan Internet eXchange (TWIX-HiNET)	http://www.twix.net/
Thailand - ThaiSarn Public Internet eXchange (PIE) http://ntl.nectec.or.th/pie/	
UAE - The Emirates Internet eXchange	http://www.emix.net/

North America - Internet eXchanges

Canada - The Edmonton Internet eXchange (EIX)	http://www.eix.net
Canada - The Toronta Internet eXchange (TORIX)	http://www.torix.net
Canada - The Vancouver Internet eXchange (BCIX)	http://www.bc.net/services
US - The New Mexico Internet eXchange (NMIX)	http://www.nmix.net
US - The Baltimore NAP (ABSnet)	http://www.baltimore-nap.net
US - The Boston Internet eXchange MXP	http://www.bostonmxp.org
US - The Chicago NAP	http://nap.aads.nett/main.html
US - The Colombus Internet eXchange (CMH-IX)	http://www.cmh-ix.net/
US - The Dallas MAE	http://www.mae.net/
US - The Denver Internet eXchange (DIX)	http://www.thedix.net/
US - The Mountain Area eXchange (MAX)	http://www.themax.net/
US - The Hawaii Internet eXchange (HIX)	http://www.lava.net/hix/
US - The Houston NAP	http://www.compaq-nap.net/
US - The Indianapolis Internet eXchange (IndyX)	http://www.indyx.net/
US - The Los Angeles International Internet eXchange (LAIIX)	http://www.laiix.net
US - The Los Angeles 6IIX eXchange points for IPv6	http://www.6iix.net
US - The Los Angeles MAE	http://www.mae.net/la.map.html
US - The New York International Internet eXchange (NYIIX)	http://www.mae.net/la.map.html
US - The Palo Alto Internet eXchange (PAIX)	http://www.paix.net/
US - The Philadelphia Internet Exchange (PhIIX)	http://www.phlix.net/
US - The Pittsburgh Internet Exchange (PITX)	http://www.pitx.net/
US - The San Antonio Metro Access Point (PhIIX)	http://www.fc.net/map/samap
US - The San Jose MAE Ames (NASA)	http://aix.arc.nasa.gov
US - The Seattle Internet Exchange (SIX)	http://www.altopia.com/six/
US - The Washington DC MAE-East	http://www.mae.net/" \l "East
US - The Washington DC Neutral NAP	http://www.neutralnap.net/

US - The Vermont Internet eXchange (VIX) http://www.vix.org/
US - The Virginia MAE (MAE Dulles) http://www.maedulles.net/

Western Europe - Internet eXchanges

Austria - The Vienna Internet eXchange (VIX) http://www.vix.at/
Belgium - Belnet (BNIX) http://www.belnet.be/bnix
Cyprus - The Cyprus Internet eXchange (CyIX) http://www.cytanet.com.cy/cyixen.html
Denmark - Danish Internet eXchange (DIX) Lyngby http://www.uni-c.dk/dix/
Finland - Finnish Commercial Internet eXchange (FCIX) Helsinki) http://www.ficix.fi/
France - Paris Internet eXchange (PARIX) http://www.parix.net
France - French Global Internet eXchange (SFINX) http://www.sfinx.tm.fr/
Germany - The Deutsche Central Internet eXchange (DE-CIX) Frankfurt
http://www.eco.de/408.htm
Greece - The Athens Internet eXchange (AIX) http://www.aix.gr/
Ireland - The Internet Neutral eXchange (INEX) http://www.inex.ie/
Italy - The Milan Internet eXchange (MIX) http://www.inex.ie/
Italy - NAP Nautilus (CASPUR) http://www.nap.inroma.roma.it/
Luxembourg - The Luxembourg Internet eXchange (LIX) http://www.lix.lu
Netherlands - The Amsterdam Internat eXchange (AMS-IX) http://www.ams-ix.net/
Norway - Norwegian Internet eXchange (NIX) http://www.uio.no/nix
Portugal - The Portuguese Internet eXchange (PIX) http://www.pix.pt/
Scotland - Scottish Internet Exchange (ScotIX) http://www.scotix.com/
Spain - El Punto Neutral Espanol (ESPANIX) http://www.espanix.net/
Sweden - The Netnod Internet eXchange (D-GIX) http://www.netnod.se/
Switzerland - The Swiss Internet eXchange (SIX) http://www.six.ch/
Switzerland - Geneva Cern (CIXP) http://wwwcs.cern.ch/public/services/cixp/index.html
Switzerland - Zürich Telehouse Internet Exchange (TIX) http://www.telehouse.ch/tix.htm
United Kingdom - The London INternet eXchange (LINX) http://www.linx.net/
United Kingdom - Manchester Network Access Point (MaNAP) http://www.manap.net/
United Kingdom - London Network Access Point (LoNAP) http://www.lonap.net/

Eastern Europe - Internet eXchanges

Bulgaria - The Sofia Internet eXchange (SIX - GoCIS)
Czech Rep. - Neutral Internet eXchange (NIX) Prague http://www.nix.cz/
Latvia - The Global Internet eXchange (GIX) LatNet http://www.nic.lv/gix.html
Romania - The Bucharest Internet eXchange (BUHIX) http://www.buhix.ro/
Slovakia - The Slovak Internet eXchange (SIX) http://www.six.sk/
Ukraine - The Central Ukrainian Internet eXchange http://www.cuix.dp.va/

CIS - Internet eXchanges

Russia - The Russian Institute for Russian Networks http://www.ripn.net:8080/ix/en/index.cfm

Africa - Internet eXchanges

South Africa - Capetown Internet eXchange (CINX) http://www.jinx.net.za/cinx/
South Africa - Jo'burg INternet eXchange (JINX) http://www.jinx.net.za/jinx/

Asia - Internet eXchanges

Australia - AusBONE (Sydney,Melbourne,Brisbane,Adelaide) http://www.ausbone.net/sydney.htm
China _ The HongKong Internet eXchange (HKIX) http://www.hkix.net/
Indonesia - The Indonesia Internet eXchange (iIX) http://www.iix.net/
Japan - The Japanese Internet eXchange (JPIX) http://www.jpix.co.jp/
Malaysia - The Kuala Lumpar Internet eXchange (KLIX) http://www.klix.net/
New Zealand - The New Zealand Internet eXchange (NZIX) http://www.waikato.ac.nz/NZIX/
Pakistan - Pakistan National Access Point (PNAP) http://www.nap.com.pk/
Philippines - The Philippines Internet eXchange (PHIX) http://www.phix.net.ph/
Saudi Arabia - The Internet Services Unit (KACST-ISU) http://www.isu.net.sa/

Singapore - SingTel IX	http://www.stix.net/
South Korea - The Korean Internet eXchange (KINX)	http://www.kinx.net/
Taiwan - The Taiwan Internet eXchange (TWIX-HiNET)	http://www.twix.net/
Thailand - The Thailand Internet eXchange (THIX) Bangkok	http://www.cat.net.th/new/Services/THIX/thix.html
Thailand - ThaiSarn Public Internet eXchange (PIE)	http://ntl.nectec.or.th/pie/
UAE - The Emirates Internet eXchange	http://www.emix.net/

South America - Internet eXchanges

Brazil - An Academic Network at Sao Paulo (PTT-ANSP)	http://www.ansp.br/
Chile - Chile National Access Point	http://www.nap.cl/
Colombia - Internet Nap	http://www.interred.net.co/
Panama - Senacty	http://www.senacyt.gob.pa/

9. Conclusion

IXP in India will facilitate in achieving the following benefits:

9.1 For Users

The cost of Internet Connectivity and bandwidth would be reduced and Quality of Services improved resulting in spread of Internet in India

9.2 The Economy

Foreign Exchange Savings
Internet Penetration Increases
Growth in Software Development
Overall Development of Economy

9.3 ISPs and Other Bodies

Better Business Viability
Better Internet Infrastructure in India
Substantial Cost Savings
Optimum Utilisation for International Bandwidth